UNIVERSITI PUTRA MALAYSIA

DESIGN AND DEVELOPMENT OF A TRAILED TYPE TRANSPLANTER FOR OIL PALM SEEDLING

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DESIGN AND DEVELOPMENT OF A TRAILED TYPE TRANSPLANTER FOR OIL PALM SEEDLING

By

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Thesis Submitted in Fulfilment of the Requirement for the Degree of
Master of Science in the Faculty of Engineering
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January 2002

Dedicated to

His late father Almarhum Yulius Amadin
His mother Rosma
His elder brother and sister in
law, and all their children

Abstract of thesis submitted to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for Degree of Master of Science

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A trailed type transplanter that runs by a 4-wheel tractor with at least 63.4 kW for field transplanting of oil palm seedlings had been designed, developed and tested. AutoCAD 2000 software was used to produce the 3-D conceptual design of the proposed machine system. Computations were made to determine required total hydraulic pressure to operate all actuators within the hydraulic system of the transplanter. The machine configuration consists of the main chassis, seedling bin, seedling planting assembly, operator compartment, and associated hydraulic system. Two operators are required in the involved transplanting operation; a driver for the tractor and an operator for transplanter. The driver drives the tractor-transplanter in the field while the operator on the transplanter operates the hydraulic control system to integrate all operational activities. The involved operational activities includes the preparations of planting hole, placement of seedling in the prepared hole, covering of the seedling in the prepared hole, and compacting of the soil around the planted seedling. An area size of 200 m length and 56 m width at the university farm was chosen to be the test plot for the five days field evaluations duration. A special time

and motion study was conducted on the 6th day of the field evaluation to include additional activity concerning removal of plastic polybag from seedling before planting. The test plot soil is from Serdang series with sandy clay loam texture classification. A triangular planting pattern with density of 160 palms/ha, planting distance of 850 cm and row distance of 736 cm were employed in the test plot.

Results of the field evaluations indicates that this mechanised transplanting system has a planting capacity of 99 seedlings/man-day or 0.62 ha/man-day as compared to 0.28 ha/man-day or 45 seedlings/man-day with the manual transplanting planting system. The estimated planting cost is RM2.11 per seedling with mechanised transplanting as compared to RM2.26 per seedling with manual transplanting. Conclusively, this mechanised transplanting system could give 2.2 times improvements in the planting capacity and 6.64 percent reduction in the transplanting cost. A cost saving of RM0.15 per seedling was obtained with the mechanised system over the manual system.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi syarat ijazah Master Sains

MEREKA BENTUK DAN MEMBINA SEBUAH MESIN TANAM JENIS HERET UNTUK MENANAM ANAK BENIH KELAPA SAWIT

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Satu mesin tanam anak benih kelapa sawit di ladang jenis heret dari traktor 4-roda yang berkuasa enjin sekurang-kurangnya 63.4 kW telah direka bentuk, dibina serta diuji. Perisian AutoCAD 2000 telah digunakan untuk menghasil konsep rekabentuk 3-D mesin yang dicadangkan. Pengiraan dibuat untuk menentukan jumlah tekanan hidraul yang diperlukan untuk menggendalikan semua penggerak dalam sistem hidraul mesin tanam tersebut. Pembinaan mesin terdiri dari casis utama, bekas anak benih, pemasangan penanam anak benih, ruang pengendali mesin, serta sistem hidraul yang berkaitan. Dua orang pengendali diperlukan dalam kerja penanaman yang terbabit; seorang pemandu traktor dan seorang pengendali mesin tanam. Pemandu memandu traktor serta mesin tanam dalam ladang, sementara pengendali mengendalikan sistem kawalan hidraul untuk menggabungkan semua aktiviti pengendalian. Aktiviti-aktiviti pengendalian termasuk penyediaan lubang anak benih, pembekalan anak benih ke dalam lubang yang telah disediakan, pengambusan anak benih, dan pemadatan tanah di keliling anak benih yang telah

ditanam. Satu kawasan di ladang universiti yang berukuran 200 m panjang dan 56 m lebar telah dipilih sebagai kawasan penilaian mesin untuk jangka masa lima hari. Satu kajian khas masa dan pergerakan dilaksanakan pada hari ke-6 untuk melibatkan aktiviti penanggalan plastik polibeg dari anak benih sebelum penanaman. Jenis tanah kawasan ujian adalah dari siri Serdang dengan klasifikasi tekstur liat lom berpasir. Penanaman bercorak tiga segi dengan kepadatan bersamaan 160 anak benih kelapa sawit/ha dengan jarak tanaman 850 cm dan jarak barisan 736 cm telah diamalkan pada kawasan ujian.

Keputusan penilaian di ladang menunjukkan bahwa sistem penanaman berjentera mempunyai kemampuan penanaman yang bersamaan 99 anak benih/pekerja-hari atau 0.62 ha/pekerja-hari berbanding kepada 0.28 ha/pekerja-hari atau 45 anak benih/pekerja-hari dengan sistem penanaman secara manual. Anggaran kos penanaman adalah RM2.11 bagi setiap anak benih dengan sistem penanaman berjentera berbanding kepada RM2.26 bagi setiap anak benih dengan sistem penanaman secara manual. Kesimpulannya, sistem penanaman berjentera boleh memberi peningkatan sebanyak 2.2 kali ganda dalam kemampuan penanaman dan 6.64 peratus pengurangan dalam kos penanaman. Penjimatan kos bersamaan RM0.15 bagi setiap anak benih boleh diperolehi dengan sistem penanaman berjentera berbanding kepada sistem secara manual.

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I certify that an Examination Committee met on 7th January 2002 to conduct the final examination of Darius El Pebrian on his Master Degree thesis entitled "Design and Development of a Trailed Type Transplanter for Oil Palm Seedling" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

DARIUS EL PEBRIAN

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CHAPTER I

INTRODUCTION

Oil palm is one of the major plantation crops in Malaysia. This country has successfully developed the oil palm plantation industry for the past three decades and it is still the largest palm oil producers in the world. Palm oil is always associated with Malaysia as the country continuous to dominate its global production and export. Malaysia became the world's largest producer and exporter of palm oil, replacing Nigeria as the chief producer since 1971. Malaysia then produced 589,000 tones, while at the same time Nigeria produced 460.000 tones. Malaysia's production of palm oil in 1998 contributed to about 49.5 percent of world palm oil output and 8.2 percent of world output of the major oils and fats. By 2000, Malaysia's production of palm oil had increased to 10,842,000 tones. (PORLA, 1999; MPOB,2001).

Declining palm oil prices due to excess supply has made the replanting of old palms as the best approach to recover back its price. Under the replanting scheme, palms exceeding 25 years old are to be cut and replaced with higher yield seedlings for a targeted production reduction of 600,000 tones of palm oil per year for the 3 years period. Incentives are given to small holders and plantations to carry out the replanting schemes of old palms. By the end of July 2001, a total of Malaysia's stock palm oil had been curtailed to 921,000 tones from 1,400,000 tones in the early last

year and a total of 180,000 hectares had been registered to be replanted under the scheme (Anon, 2001).

Planting operation is one of most important field operations in the plantation urgently need to be mechanised in view of the earlier mentioned problem. By year 2000, the total area under oil palm cultivations in Malaysia had increased to 3,376,664 hectares as compared to 641,791 hectares in 1975. These cultivated areas were under small holders, FELDA, FELCRA, RISDA, State Scheme and private estates and were distributed throughout in Malaysia peninsular, Sabah and Sarawak. (MPOB, 2001). The planting operation could affect the total productivity of the cultivated area since it is the earliest operation to be considered in any cultivation. Consequently, good planting technique and practice would enhance the production level of the cultivated area.

Turner and Gillbanks (1974) mentioned that there are several activities that are involved in the oil palm seedling transplanting operation. These include; holing the ground for placing the seedling, transporting the seedling from the nursery to the field, transporting the seedling in a tray or sling from roadside to the prepared planting hole, placing the seedling to already prepared hole and finally compacting the filled soil around the planted seedling.

Tremendous efforts have to be made to maintain the country present status production position due to stringent competition among other palm oil producing countries. One of the efforts is to promote mechanisation in the oil palm plantation in order to combat labour problems and maintain production. Implementing

mechanisation is possible since according to Basiron (1998) almost all field operations in the plantation could be mechanised with the exception to the cutting operation of fresh fruit bunches.

Presently, oil palm seedlings are manually transplanted in the plantation field in Malaysia. The planting hole is either prepared manually with a hoe or with the use of a mechanised drill. The drill could be a portable powered post hole digger or a tractor mounted powered digger. Normally, the holes are prepared a few days prior to the planting of seedlings. Planting at times began as soon as field preparations have been completed. During planting, the field worker manually places the seedling in the prepared hole, covers the seedling and compacts the soil around the planted seedling using a hoe. The involved operations are laborious, drudgery and time consuming.

Manually planting according to Hartley (1977) requires 16.5 men-day per hectare in Malaysia. The task imposed extensive stress and fatigue to the field workers and thus become an unattractive job for others to pursuit. Furthermore, the present planting techniques that are widely practised are inefficient and unproductive since the planting holes are to be prepared a few days before actual planting commence. As mentioned by Rankine and Fairhurst (1999), the hole digging and planting capacity under optimum work rate on mineral soil is only 45 palms/man-day. Meanwhile planting capacity without hole digging for the same work rate and soil is 90 seedlings/man-day. However, workers under optimum work rate on peat soil could plant only a total of 40 seedlings/man-day. With planting only and excluding digging hole, the workers are capable to plant 80 palm/man-day.

Various types of transplanting machines are now available in the market. However, no machine has been designed, developed or adopted for oil palm seedling. Most of transplanting machines reported in the literature were designed and developed for cereal crops, vegetable crops, and a few for tree crops and shrubs.

Modern and efficient methods of transplanting seedling need to be introduced in the oil palm plantation. There is a need to mechanise all activities in transplanting operation. This could be achieved by integrating all activities in the seedling transplanting with a mechanised integrated system.

1.1 Objective

The main objective of the study is to introduce a mechanised integrated machine system for transplanting of oil palm seedling in the plantations. However, the specific objectives of the study are as follows:

i. To design and develop a fully integrated machine system for transplanting oil palm seedlings in the field

ii. To evaluate the performance of the developed prototype machine system for the oil palm seedling transplanting operation in the field

iii. To evaluate the economics of the mechanised field transplanting of oil palm seedlings with the developed prototype machine system was compared to the present manual field transplanting of oil palm seedlings

The developed prototype of the machine system would be hopefully able to fulfil the following expected outcomes:

i. Reduce of the total dependence of labour on transplanting of oil palm seedlings

ii. Reduce drudgery and fatigue of workers in transplanting of oil palm seedlings

iii. Improve the productivity of workers in transplanting of oil palm seedlings

iv. Make agriculture an attractive profession in Malaysia.

The designed and developed machine system would be limited to be used to plantations with proper machine path, adopt terrace planting, and terrains with mineral soil type. In addition, the oil palm seedlings to be planted should not be more than 16 months old and 1400 mm in height after pruning, and the seedlings should be prepared in 36 x 28 cm size polybags.

CHAPTER II

LITERATURE REVIEW

This chapter reviews on of oil palm fruit characteristic, oil palm seedling, oil palm planting, basic functions of planters and grain drill, and past research and development on specialised planting machine, and specialised tree planting machine.

2.1 Oil Palm Fruit Characteristics

Fruits characteristics are crucial to recognise before breeding them to the seedlings in the nursery. By knowing the characteristics, the grower would able to select the type of fruit used in breeding to get the expected yield and quality. The two basic types of fruit used in oil the palm breeding are Dura and Pisifera.

Dura is characterised with mesocarp percentage in the range of 35% to 50% with the exception of the Deli Dura found in the Far East having figure that reach 65%. The shell is comparatively thick with thickness in the range from 2 to 8 mm. It has no ring of fibres but large kernel. The oil content percentage of mesocarp to bunch weight usually is quite low in the range of 17 to 18%. This fruit type is used as the female parent in the breeding programmes.